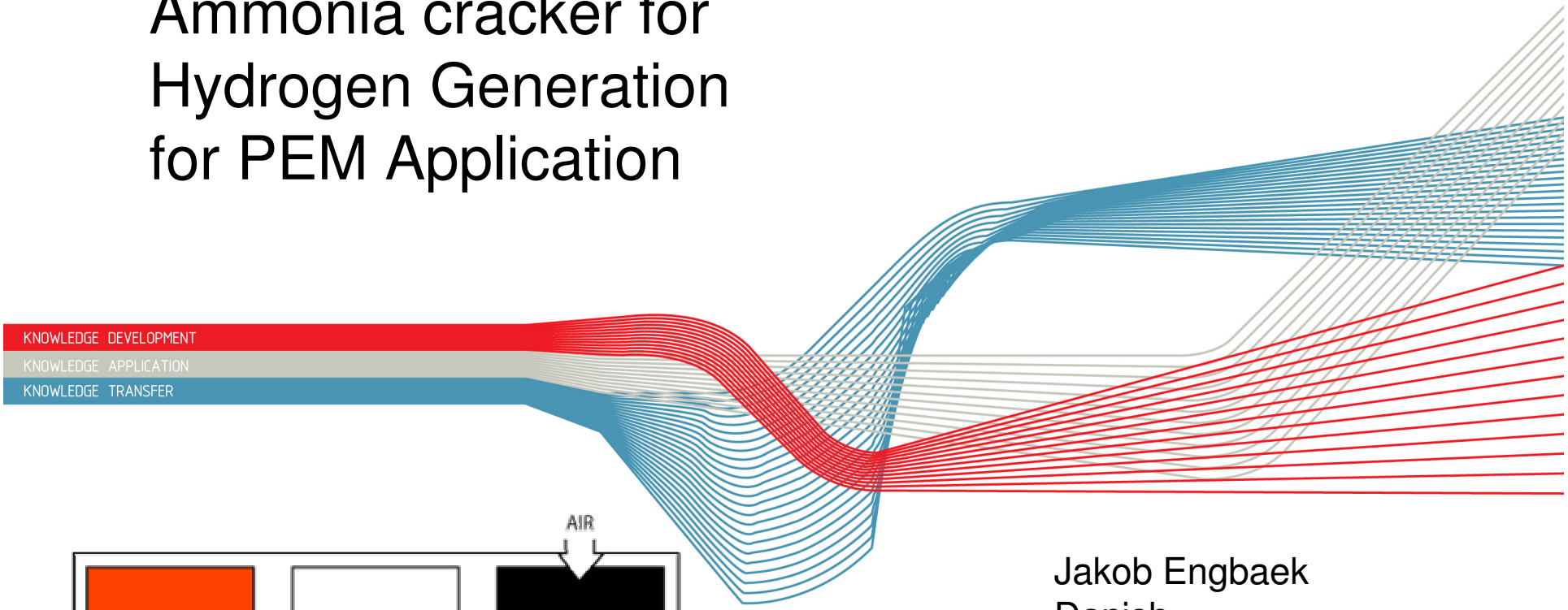
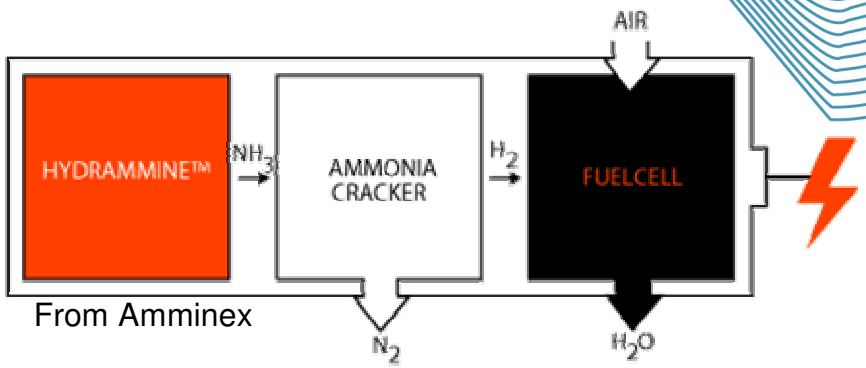
Ammonia cracker for Hydrogen Generation for PEM Application





From Amminex

Jakob Engbaek
Danish Technological Institute

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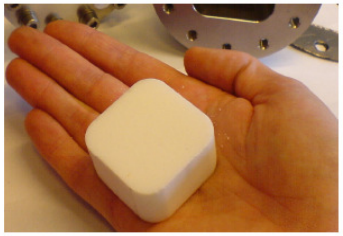
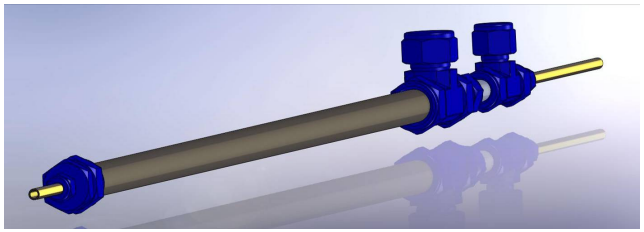
The envisioned system



Hydrammine delivering NH_3 → Ammonia Cracker $NH_3 \rightarrow H_2$ and N_2 → Absorption removes rest NH_3 → PEM Fuel cell Produce power



Fuel Cell - Battery hybrid ~1,2 kW

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Ammonia cracker design

Counter current flow to get :

- High temperature when the gas exit the catalyst bed
- improve heat exchange

Reforming

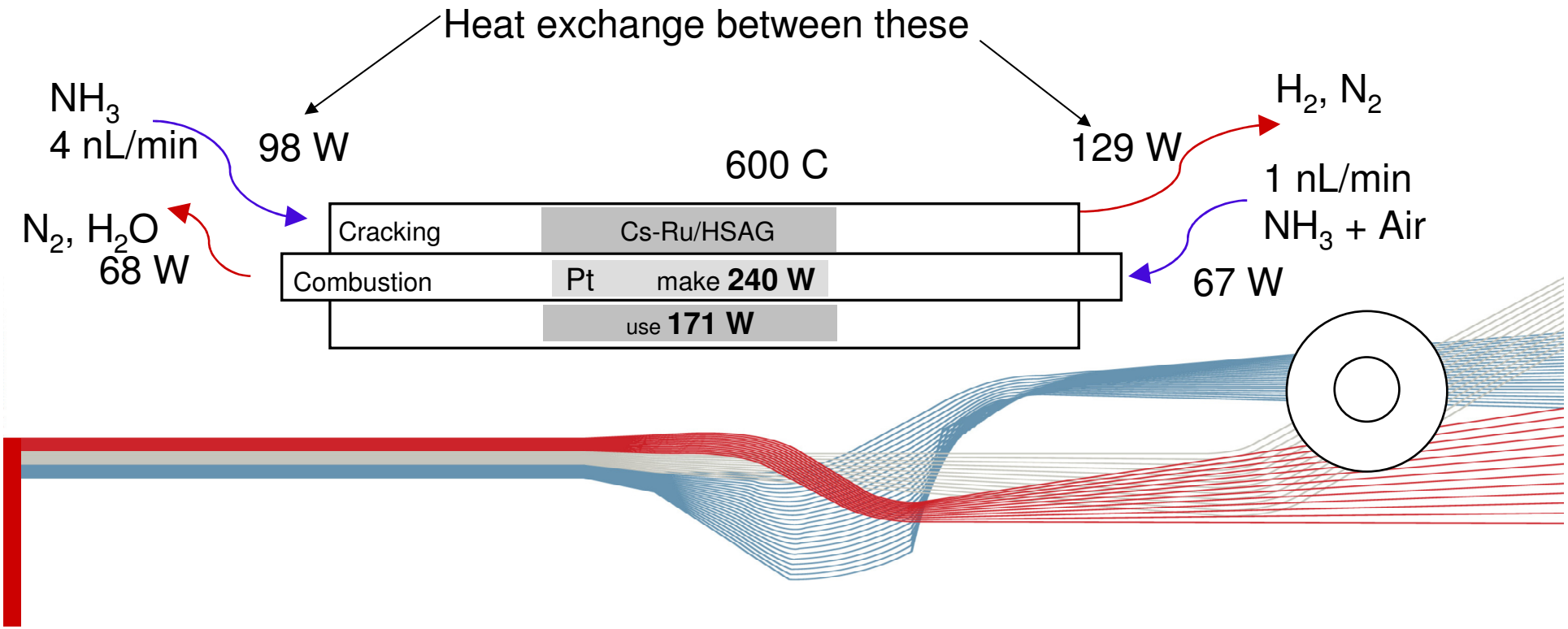
$2NH_3 \rightarrow 3H_2 + N_2$

-46 kJ/mol

Combustion

$2NH_3 + air \rightarrow N_2 + 3H_2O$

316 kJ/mol



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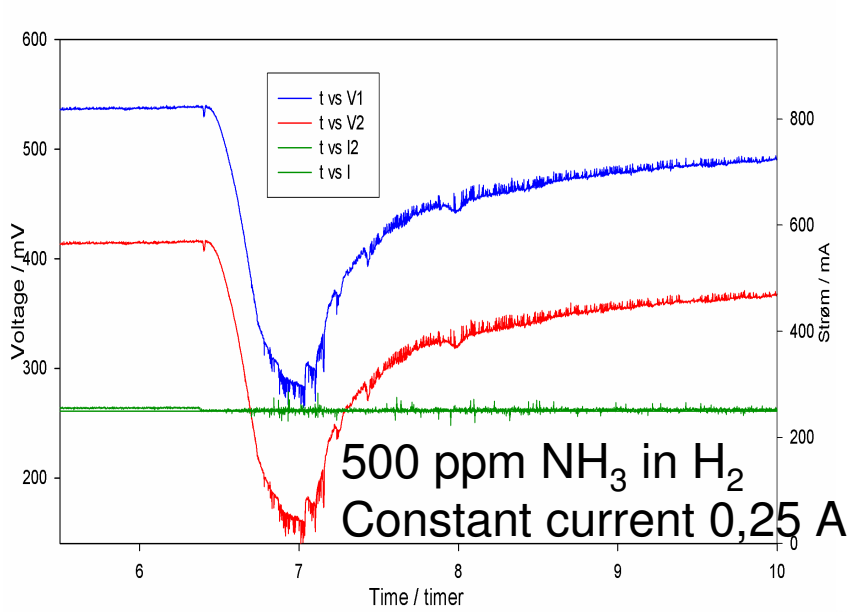
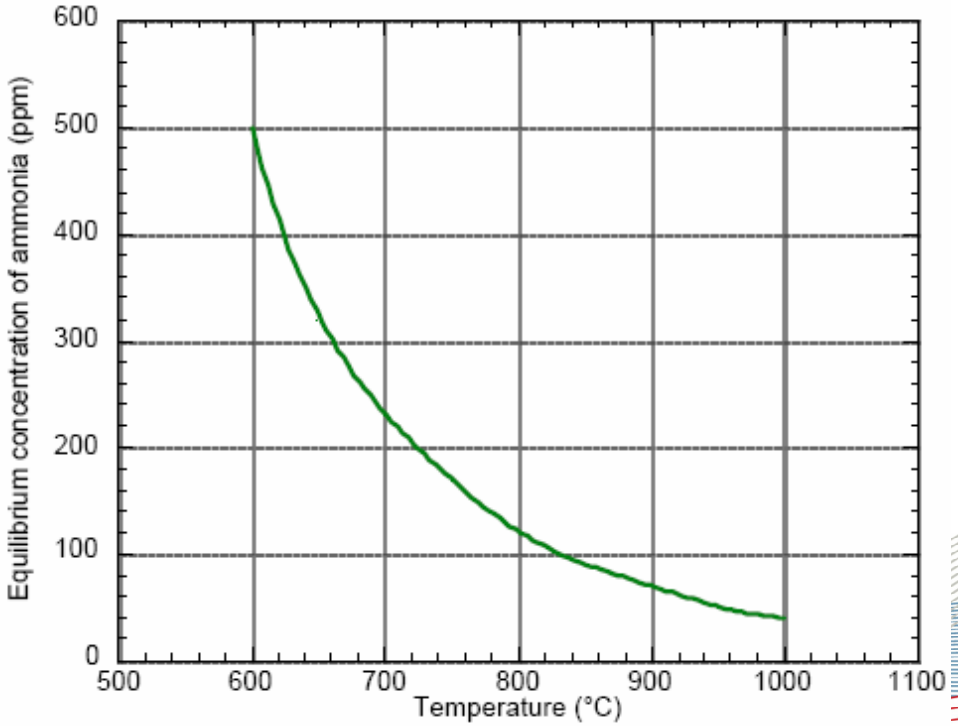
Ammonia cracker design

Filter needed, or very high temperature:
To get purity





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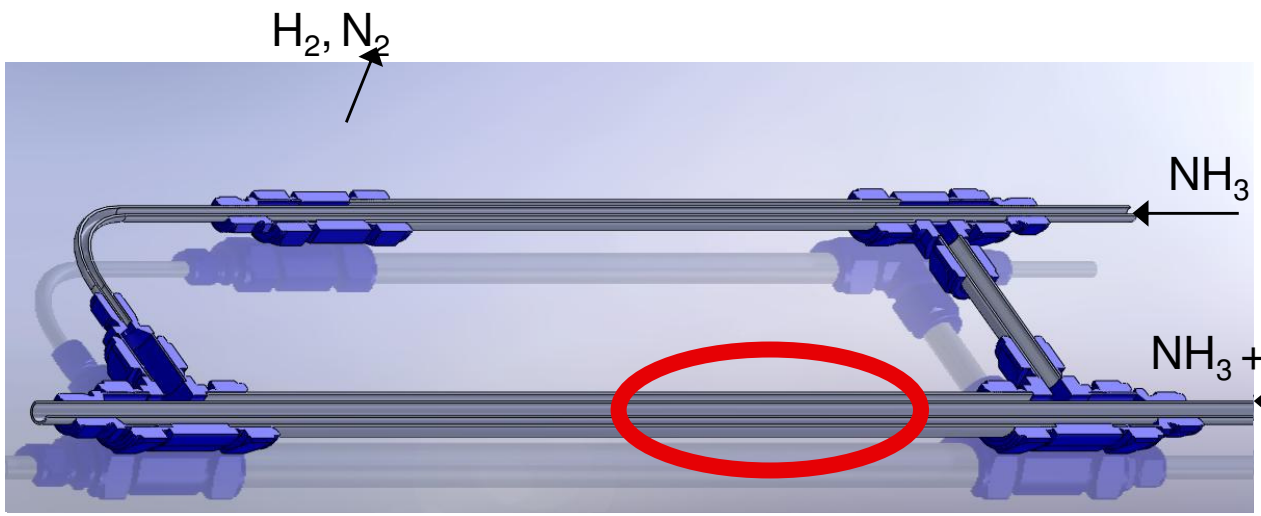
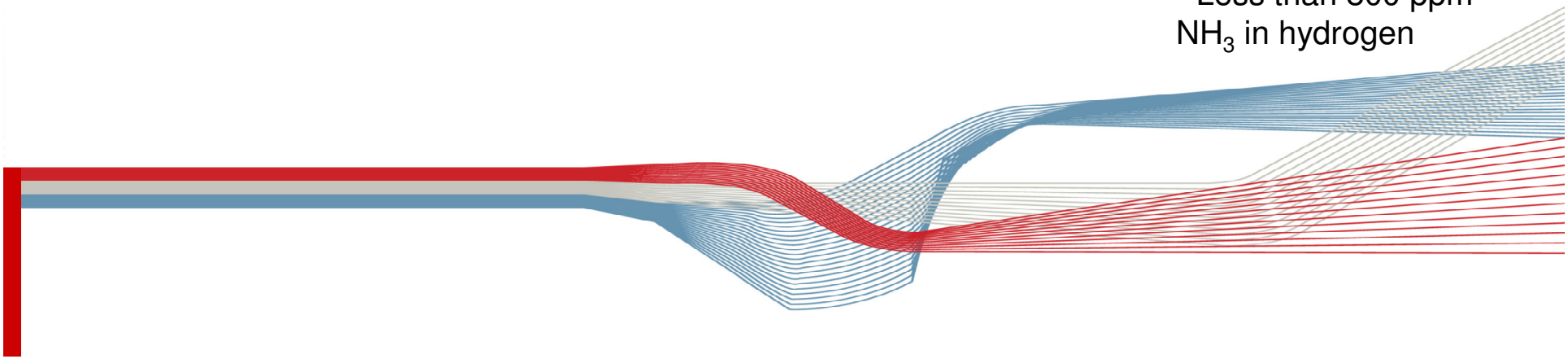
Ammonia cracker design



- Counter current flow to get high temperature when the gas exit the catalyst bed and to improve heat exchange
- Has been realized with
  - Low pressure drop
  - 80 % ammonia cracked
  - 91 % energy efficiency
  - Less than 800 ppm NH_3 in hydrogen



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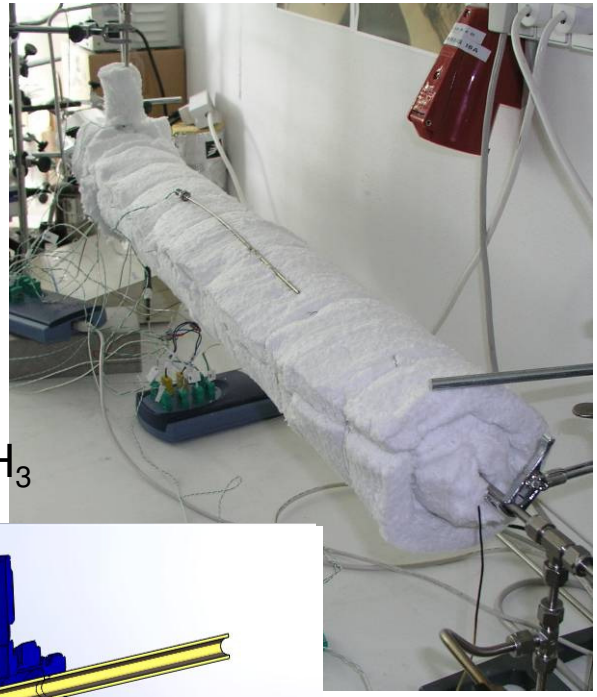
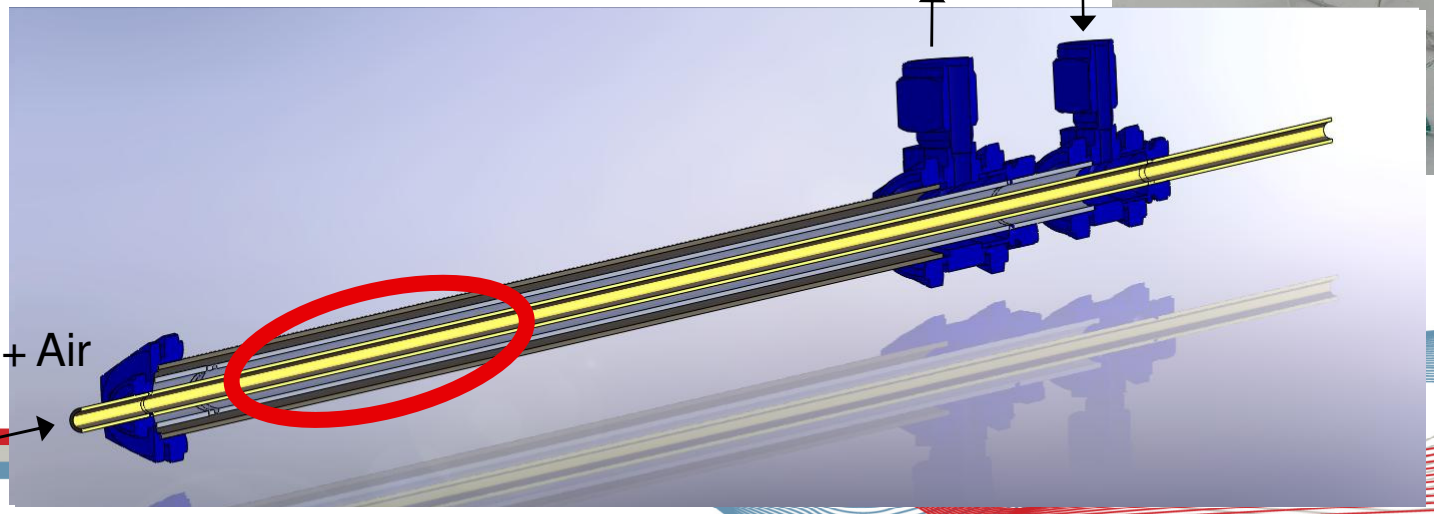
Ammonia cracker design

- More compact design
- 83 % ammonia cracked to hydrogen
- 92 % energy efficiency
- Ammonia concentration in output ~800 ppm





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Energy in the system

Hydrammine delivering NH_3	→	Ammonia Cracker NH_3 → H_2 and N_2	→	Absorption removes rest NH_3	→	PEM Fuel cell Produce power

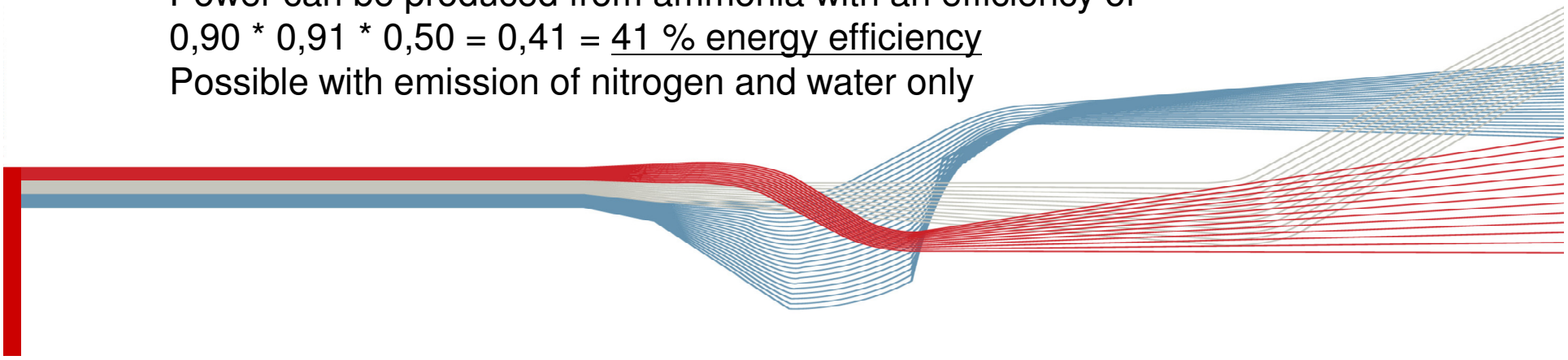
Desorption
43 kJ/mol H_2
Loss 10 % of energy in NH_3

Cracking
Conserves
91 % of energy

Limited loss in pressure only

Hydrogen converted to power 50 % efficiency

Power can be produced from ammonia with an efficiency of
0,90 * 0,91 * 0,50 = 0,41 = 41 % energy efficiency
Possible with emission of nitrogen and water only



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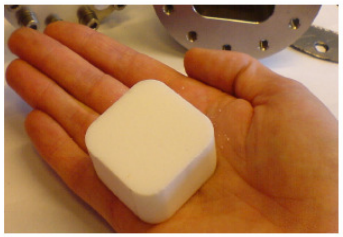
The envisioned system



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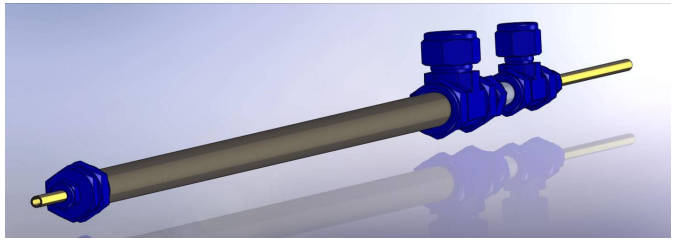

FC-battery hybrid with ~1,2 kW FC

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